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Vol. XI. Part I. April, 1938.

THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

Edited by

ROLAND V. NORRIS, D.Sc., F.I.C.,

Director, Tea Research Institute.

THE TEA RESEARCH INSTITUTE,

St. Coombs, Talawakelle.

PRINTERS H. W. CAVE & CO., COLOMBO.

The Tea Research Institute of Ceylon.

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EDITORIAL.

TEA SUPPLIES

A survey of the tea growing on the majority of estates in Ceylon reveals much more marked differences in uniformity and jât than is apparent in other countries. The indication to be drawn from this is that our sources of supply are in urgent need of attention in order that a greater degree of uniformity may be attained within the jâts available for planting.

The Institute is anxious to be of assistance to estates in this direction and, as a step towards this end, has been endeavouring to obtain the fullest possible information in regard to seed-bearers in Ceylon. It is to be regretted that in response to the request for such information made in the last *Tea Quarterly* only three replies were received. The pooling of information in regard to existing jâts in Ceylon would facilitate the Institute's attempts to help those interested in supplying seed to improve their types and another appeal is made for co-operation in this matter.

It should perhaps be made clear that the Institute, for obvious reasons, cannot undertake to recommend to estates any particular sources of seed. It is considered, however, that the Institute can help in improving these sources and it must then remain the responsibility of any prospective purchaser of seed to satisfy himself that the bearers under consideration are of satisfactory type and uniformity.

In addition to attention to existing seed-bearers, the Institute is actively engaged in selection work, the aim being of course to obtain types of better quality and with higher-yielding capacity. At the same time the question of the multiplication of such selected material is under investigation.

At present such selection has to be conducted on local material. The importation into Ceylon of tea seed from North-East India, where a much wider variety of better defined jâts is available, is still prohibited under the Plant Pest Ordinance in order to avoid the risk of introducing new pests or diseases. It is considered, however, that such a risk would be reduced to a minimum in the case of small quantities of seed imported under suitable precautions by the Institute and kept under the constant observation of the Institute's technical staff. An application is therefore to be made for a relaxation of the regulations under the Plant Pest Ordinance *in*

respect of seed required for the Institute's own selection experiments. If this be successful, it will be possible considerably to enlarge the range of material available for selection.

In such work close contact is being maintained both with Java and India where similar investigations are in progress.

APPLICATION OF SCIENCE IN TEA CULTURE

In the January (1938) number of *The Empire Journal of Experimental Agriculture*,* Mr. P. H. Carpenter, the Chief Scientific Officer of the Tocklai Experimental Station, Assam, gives an interesting review of recent trends of research work on tea. In view of what has been written above it will be of interest to include the following quotation from Mr. Carpenter's article:—

> "Tea is planted out from seed collected from many sources, but the first tea-gardens were established with plants brought directly from China, or from seed imported from China. Subsequently tea was found growing wild in Assam which was at first thought to differ so greatly from the Chinese variety that it was unlikely to make commercial tea. This view was, however, disproved, and it is from this source that the modern tea-gardens have developed. Seed from Assam has been sent to the other tea-growing countries, and these in their turn have developed their own seed-gardens. The original seed of the Assam type was collected in the jungles and was used for making seed-gardens. Owing to carelessness and ignorance of methods likely to ensure effective selection, there exists to-day no commercially known pure-line variety of tea. The progeny from all seed-gardens is much hybridized, and it is evident to any casual observer that the plants raised from any one seed-garden give progenies which differ considerably amongst themselves in appearance. Experiments have shown also that the characteristics of the tea manufactured from individual bushes differ considerably. In a broad way it is recognized that certain kinds of tea plant are suitable for certain cultural and climatic conditions, but even so, the variation found among plants from any commercial type of seed is likely to be as great as that between the commercial types themselves. Very great improvement would result if uniform characteristics could be achieved in the product from any one seed-garden.
>
> "In the Netherlands East Indies much work has been done in the direction of selecting bushes for some desirable quality and vegetatively reproducing such bushes by budding. The botanist of the Thee Proefstation, Java, has now a number of such clones undergoing trial. Of more recent years intensive work has been begun in Russia along the same lines, employing either budding or cutting as the method of vegetative reproduction

* P. H. Carpenter.—"The Application of Science to Modern Tea Culture."—*The Empire Journal of Experimental Agriculture*, 1938 (VI, 1).

Particular attention in this case has been paid to the development of frost-resistant strains. Tunstall, at Tocklai, undertook experiments on the production of tea bushes from cuttings, but no systematic work was possible in the absence of a botanist, and it was not until 1930 that one was appointed. Since then work in this direction has been in progress. Attention is also being paid to selection work in Ceylon. This work is in its early stages and has not yet been developed commercially. In Java, however, one seed-garden raised by budding is to-day established and yielding seed.

"It is in the direction of variety selection and the production of uniformity in the progeny of tea seed-gardens that the next big development in tea culture is likely, and indeed might almost be said to have begun, for the importance of research in this direction is now recognized throughout the industry."

In regard to the application of science generally in the tea industry, Mr. Carpenter points out that Java was the first to appreciate the need for such work. A few years later, in 1899, the first scientific officer was appointed to the Indian Tea Association. In Ceylon investigations on tea soils were first begun by Bamber in 1898, but it was not until 1925 that the Tea Research Institute was inaugurated. Other research stations now exist in South India, Russia, Japan and East Africa.

One of the first questions to be investigated was the question of soil fertility and Mann first introduced the systematic use of nitrogenous fertilisers in tea, rape cake being applied at the rate of about 400 lbs. per acre. Somewhat later arose the practice of growing leguminous crops in the tea to enrich the soil with nitrogen and improve the tilth.

Carpenter gives an interesting summary of the developments that have since occurred in manuring practice. As the result of field experiments carried out at Tocklai, the use of inorganic forms of nitrogen was begun, though there was at first considerable prejudice, not yet extinct, against such a practice.

Carpenter's conclusions which of course relate to Indian conditions, and are based on long continued experiments at the Tocklai Station, are indicated by the following quotation from his article:—

"Fully replicated field experiments in all the tea-growing countries have, however, demonstrated the value of nitrogen in the inorganic form of sulphate of ammonia. At Tocklai replicated field experiments have now been carried on for over 17 years in which the same kind of manure has been added annually to the same plots. The results show that sulphate of ammonia, if used to supply an equal quantity of nitrogen, gives results as good or

better than those obtained from organic manures such as oilcake, cattle manure or green manure, or cuttings of leguminous plants, (*e.g., Tephrosia candida*).

"It is often maintained that cattle manure is valuable not only because it supplies nitrogen but also because of its bulk of organic material. Experiments carried out at Tocklai have shown that over a period of 4 years an annual application of 5 tons of cattle manure supplying 60 lb. of nitrogen has given an increase of 765 lb. of tea per acre, whereas in another experiment an annual application of 60 lb. nitrogen as sulphate of ammonia has given over the same 4 years an increase of 1,580 lb. of tea per acre. Similar results have been obtained in other experiments, indicating that for the same application of nitrogen, cattle manure possesses about one-half to one-third the efficiency of sulphate of ammonia. It is sometimes claimed that cattle manure is slow-acting and that its effect will be felt over a large number of years. Actual trial, however, shows that one application of 20 tons per acre of cattle manure containing 160 lb. of nitrogen produces a crop-increase over 4 years, but for no longer. An application of an equal quantity of nitrogen as sulphate of ammonia gives about double the increase in crop over the same period of time. It does not, therefore, appear from these experiments that cattle manure is an efficient manure, nor does it give increases of crop over any long period of time.

"Nitrogenous manures seem to give an increase in crop proportional to the amount of nitrogen supplied :—

Nitrogen applied annually		Average annual gain in crop in lb. of tea per acre
lb.		lb.
40	...	256
80	...	535
120	...	721

"The crop-increase obtained is proportional to the amount of nitrogen that becomes quickly available to the tea plant, and a slow-acting manure is generally synonymous with an inefficient manure. The amount of increase obtained per lb. of nitrogen applied varied with the soil and other conditions. Broadly speaking, the higher the natural cropping capacity of the soil the less the response from nitrogenous manuring.

Place	Crop increase in lb. of tea per acre per lb. N for doses of 40 lb. N per acre per annum
Tocklai (Assam)	6.4 lb.
Tulsipara (Bengal, Dooars)	5.1 ,,
St. Coombs (Ceylon)	4.4 ,,

"For a certain quantity of nitrogen added annually to the soil the tea crop will increase until it reaches a certain maximum dependent upon the amount of nitrogen added annually. This rise to a maximum does not take place at once; there is a steady increase, which at Tocklai with an application of 40 lb. of nitrogen reaches a maximum in about the fifth year of continuous manuring. On experimental plots the increased crop in lb. of tea per acre for an application of 40 lb. of nitrogen per acre is:—

First year	...	3.3 lb. crop per lb. nitrogen
Second year	...	5.0 ,, ,, ,, ,, ,,
Third year Fourth year	...	6.4 ,, ,, ,, ,, ,,
Fifth year	...	8.0 ,, ,, ,, ,, ,,

"A commonly expressed opinion, backed however by no evidence, is that the continual use of a manure, such as sulphate of ammonia, to tea results eventually in the depletion of organic matter in the soil. Such opinion has strongly advocated the use of bulk organic manures for tea. An experiment that has now been continued for 17 consecutive years compares the effect of sulphate of ammonia with that of cuttings from *Tephrosia candida* supplying an equal quantity per acre of nitrogen. So far no advantage is shown from the use of the bulk manure in the condition of either tea bush or soil. Throughout the experiment sulphate of ammonia has proved superior and still continues to do so.

"An important experiment has shown that the use of sulphate of ammonia continued annually has resulted in an increase of soil nitrogen and organic matter varying with the amount of sulphate used.

Fertilizer nitrogen applied annually over 7 years lb.	Loss on ignition of dry soil (organic matter). per cent	Nitrogen in dry soil per cent
0	2.80	0.094
40	2.93	0.096
80	3.09	0.101
120	3.10	0.104

"The supposition that the use of 'artificial' nitrogen on tea soils 'exhausts' the soil of organic matter and nitrogen is the reverse of the truth. These results may at first seem somewhat surprising, but a little knowledge of tea culture permits a simple understanding of the facts. Tea bushes are planted about 4½ feet apart, and by pruning and plucking are

maintained at a height of about 3 feet to 4 feet from the ground. During the year new growth develops, part of which is removed by plucking; most of the remainder is buried at the next pruning. In North-East India, and in the particular instance under consideration, the pruning was done annually, and the weight of prunings which were turned into the soil increased with the weight of manure used.

Nitrogen applied annually over 7 years lb. per acre		Dry weights of prunings tons per acre
nil	...	1.0
40	...	1.5
80	...	2.0
120	...	2.3

"With the increased doses of nitrogen there is an increased growth of bush, and consequently an increased weight of prunings that are returned to the soil. The prunings, whether from very heavily manured or from unmanured plots, had the same composition. Such prunings provide an annual addition of organic matter to the soil which in decomposing is able to render at least a part of its nitrogen available to the bush. Part, however, remains unavailable and accumulates in the soil. Whether the prunings are buried with or without the addition of soluble nitrogen appears to make no difference to the crop return that is obtained, beyond that which would be expected from the additional soluble nitrogen. In other words there is no interaction between the effect of prunings and the sulphate of ammonia so far as nitrogen supply is concerned. It would seem that nothing would be gained by composting such material, a procedure that has been much advocated of late. These results make it clear that at any rate for tea culture there need be no fear that the use of an inorganic manure, such as sulphate of ammonia, will deplete the soil of organic matter so long as the tea prunings are incorporated in the soil. It would also seem that the incorporation of the weight of organic matter as prunings into the soil is sufficient for the soil's requirements, and consequently no gain in crop is obtained by the use of bulky organic manures."

Experiments in Ceylon have likewise indicated the suitability of inorganic forms of nitrogen for tea and very great economy in the cost of manuring has resulted from their use. In Ceylon the comparison has chiefly been between sulphate of ammonia and 'organics' such as bloodmeal or groundnut cake. In these cases there has been but little difference in the yield between the different treatments.

In regard to other manurial constituents such as phosphoric acid and potash, the Indian findings reported by Carpenter suggest that potash has had a slight adverse effect on quality. In Ceylon the position is reversed in that omission of potash has been detrimental. The reason for the difference may be, as Carpenter suggests, that Assam leaf normally has a much higher potash content than Ceylon leaf.

Carpenter also reports some interesting observations on the results of cultivation. In Assam, speaking generally, it has been found that undue disturbance of the soil, *i.e.*, cultivation in excess of that required to suppress weed growth, has depressed yields.

In Ceylon, where of course soil conditions are totally different, more vigorous cultivation is generally favoured. These are not wanting indications, however, that even here this may be overdone and that soil stirring *per se* may not be beneficial.

ROLAND V. NORRIS.

NURSERY SELECTION.

F. R. TUBBS.

The history of almost every cultivated crop has begun with the cultivation of types differing little, if at all, from the wild plant. In the case of long-lived temperate crops, such as the apple, methods of vegetative propagation were developed relatively early. Dissatisfaction with the erratic types of seedling progeny, leading to the selection and propagation of desirable individual plants, resulted in the gradual elimination of the poorer types. The realisation that desirable types could be maintained by vegetative propagation, but that the dice were heavily loaded against the chance seedling of a good tree producing as good fruit as its parent, doubtless accelerated the adoption of methods of vegetative propagation.

In the case of short-lived plants whose relatively low *individual* value rendered vegetative propagation an uneconomic process, the attention and care of gardeners and plant breeders resulted in the production of improved varieties by careful methods of crossing and selection. In the majority of cases these improved varieties have been fairly well "fixed," the progeny coming true to type provided cross fertilization with other varieties is prevented. In consequence, the use of seed provides a cheap and acceptable method of propagation of such plants.

These processes of selection and fixing involve the passage of many generations of the plant, and such work has naturally tended to remain restricted to annual and biennial plants where a number of generations can be grown in a relatively short total period of time. Work upon the breeding of plants which reach maturity only after a number of years, or which are not conveniently propagated by seed, has been almost entirely restricted to those cases where it is economically feasible to eliminate the lengthy process of "fixing" the desired type by having recourse to the vegetative propagation of desirable seedlings obtained as a result of artificial crossing. The apple and the garden rose may be taken as examples.

The case of tea, where the time taken to produce seed in useful quantity, though variable, amounts to many years, and where the value of the individual bush is so low as to eliminate on economic grounds any expensive method of vegetative propagation, is peculiarly difficult. The magnitude of the problem may be illustrated by comparison with the garden onion (which produces seed in its *second*

year) for which a scheme of selection covering at least four generations is recommended merely for the improvement and purification of *existing good varieties*. In tea no such relatively pure varieties yet exist, and it is therefore to be expected that many more than four generations would be needed to achieve the same result. Adding to this the difficulty of dealing with the large numbers of progeny which must be individually tested for yield and other desirable properties, it becomes apparent that pure line breeding alone would be so stupendous and lengthy a task that no individual or group of individuals could hope to produce economic results for the benefit of the industry during the course of a life-time.

Nevertheless, there is room for great improvement in the type of tea plant used, and this applies particularly to Ceylon, which has so far displayed in tea, as in rubber, far less interest in the improvement of its planting material than have other countries. There are, however, signs that awakening interest in the problem is already resulting in individual Superintendents examining the possibilities of effecting the first stages of selection of their existing plant material with a view to improving the type of material used for replanting and supplying. Disappointments are inevitable in such work, and it is very desirable, in fact essential, that such attempts should be carefully planned with a view to eliminating as far as possible the risks of selecting plants whose apparent superiority over the average is in reality spurious. It is hoped that the following pages may be of assistance in indicating some of the pitfalls and the methods by which they may be avoided, and that it may stimulate those interested in the problem to seek assistance from the Institute in the planning of their experiments.

It will be noticed that argument is avoided upon the subject of the desirability or necessity for selection, as it is considered that no one would seriously oppose it. The real questions are "Can fixed varieties be selected and propagated *in a reasonably short time on a commercial scale and at an economic cost per plant?* If not, what progress in that direction can be achieved within the limits imposed by economic conditions?" For example, it would be of no assistance to produce a tea clone by vegetative propagation giving double the profit per acre, if its establishment involved trebling the capital value of the estate. But it might well be profitable to use the seedling progeny of selected plants, provided that the average profit-yielding capacity of such seedlings was sufficiently greater than that of the original unselected material, and in spite of the fact that some individual plants from such progeny might be little, if at all, better than the existing average.

The first criterion of selection must obviously be yield; it would appear to be inadvisable to restrict further examination of the bushes to the very highest yielders alone, however, lest by undue emphasis upon this character the types having other desirable characteristics be unintentionally excluded. It must be remembered that at present we are entirely ignorant of the genetic relationships of the various characters of the bush, and that this state of affairs will be remedied but slowly.

The second criterion of the value of a particular bush will be the market value of its produce. Tentative methods for the comparable manufacture of very small quantities of leaf have been worked out and are being examined in India and Java, as well as in Ceylon. The possibility of substantial aids to progress being contributed by the Biochemist must not be forgotten; the subject has already received attention in Russia. Timocenko considers it essential that the tannin and caffeine content of the leaf harvested be considered in selection work, and his data suggest that very large variations in tannin content may occur from bush to bush, amounting to as much as fifty-two per cent of the average content. While tannin content is by no means the only factor affecting the market value of made tea, Evans' conclusions, that seasonal price trends were associated with seasonal variations in tannin content, may be recalled. Gogh also advocates selection on a chemical basis, in Java. It is hoped to examine the variability that occurs under local conditions in the composition of the flush from different bushes in order to determine the desirability of chemical selection in Ceylon. It will not, however, be possible to commence work on this subject in the immediate future. It may be found that varieties rich in tannin present difficulties in the way of vegetative propagation by budding, and alternative methods may have to be adopted, since it has been found in several plants that a high tannin content in the cambial layer led to poor success in grafting. It is to be hoped that this subject will receive further attention.

Other desirable characters upon which the final choice of the best type will depend will be disease resistance, ease of propagation, good callus formation, rapid wound healing, and the production of fairly large flush to permit of cheap plucking. It is also possible, indeed probable, that individual bushes will be found to vary as to the rapidity of the increase in banji formation with age from pruning and in the size of the seasonal fluctuations in the amount of banji. The character of branching, etc., should also receive attention, since some bushes adopt a sympodial type of growth under plucking that leads to abnormally high rates of increase of the height of the plucking table.

It is obvious that the final selection will depend on the results of experiments and tests covering a number of years. The first step therefore lies in the selection of a number of high-yielding bushes, from which may be selected those which are desirable owing to the chemical composition of their growth, and the quality of the manufactured produce. It must also be verified beyond reasonable doubt that the high yields characterising the selected bushes are due to causes individual to the bushes, and not to the chance occurrence of favourable environmental conditions. For example, absence of competition, deeper or more fertile soil, the presence of drains or spoil earth from roads and paths, all contribute to variability of the individual yields. While it is a relatively simple matter to select the high-yielding bushes from those of lower yield, it is not possible without further experiment to divide the selected bushes whose high yield is due to inherited yield characters from those in which it is due to the chance favours of the environment. This can only be achieved by the vegetative propagation of the selected bushes and an examination of the yield capacity of a number of the individuals from each clone formed thereby. This number must be sufficiently large to ensure that the average environmental background of each clone under comparison is approximately the same. When this is the case, the yields will provide an index of the yield capacity of the clones under conditions similar to those in which the trial is conducted.

The separation of true from spurious high yielders having been achieved by properly conducted yield trials, the stage is set for a final selection of the most desirable of the high-yielding types. Thereafter the problem will be to apply the most effective means of multiplication of the selected type — either by attempts to "fix" as far as possible the desired combination of characters with a view to the subsequent commercial propagation of the type by seed, by recourse to further multiplication of the original bush selected by vegetative propagation, or by selection among the seedling progeny.

It is essential to stress the fact that there is no possibility of proved clones becoming available in Ceylon for many years. It is, therefore, of the utmost importance that immediate steps be taken to ensure that the reckless planting of almost every seedling that can possibly be called tea be abandoned, and that in future *only the very best* material available shall be used for replanting. Attention has previously been drawn to the urgent necessity of improving the type and uniformity of seed-bearers. The startling uniformity of many jâts in Java and India when compared to our own is a sufficient indication that there will be no necessity for the areas now being replanted to mirror the hopeless heterogeneity of

older areas, if care is taken by seed-producers and consumers in Ceylon. It is not perhaps generally realised that continuous selection with the aim of producing more uniform and improved jâts is actively carried on by many seed-growers in other countries. Improvement will obviously demand co-operation between the seed-producer and consumer, the former by strict attention to uniformity of the type supplied, and the latter by supporting the former by a discriminating choice of the source of seed. It is greatly to be hoped that a more lively interest will be taken by all concerned, and that it will be generally realised both by estate and agency interests, that the purchase of seed containing, say, a high proportion of sinkers is possibly less important than ensuring that time, money, and space are not wasted on a proportion of plants of undesired type, whose presence may be a source of annoyance and loss for several decades.

While harsh words have been used about Ceylon jâts in other countries, such as those of Cohen Stuart: "The consequence has been that Ceylon tea is an awful medley of tea hybrids, and that Ceylon, as a seed-producing country, stands in very bad repute among Java planters, however good its manufactured tea may be," and while we are informed that "Ceylon jât" and "Stinker" are interchangeable terms in one tea-producing country, the fact must not be lost sight of that the blame for this state of affairs cannot be justly laid on the doors of the estates who have so long borne a good name for the seed they supply, which will bear critical examination by Ceylon standards. *The fact is that the standards internal to Ceylon are being challenged by those of other countries, and no reference to variability of type can fairly be construed as criticism, but rather the drawing of attention to the fact that the evolution of the tea industry is demanding evolution in Ceylon's methods and that planting material which has served our purpose for many years will not serve us in the future, in the light of the strides made by other tea-producing countries.*

However, the planter who, while realising the fundamental importance of the issues which have to be tackled by the industry, has received instructions to replant, may well ask "What methods should I adopt at present to ensure that my planting material should at least be better than what has been used in the past, even if it is not equal to what may yet be achieved?"

It is possible for such a planter, if allowed, to achieve a distinct improvement in the uniformity and yield potentiality of his plants, as has already been abundantly demonstrated by research workers in Java, who have conducted admirable researches on this and kindred subjects. The method employed is to select from among the types of seedlings found in the nursery beds those whose characters are

the most suitable, discarding the rest. The paucity of nursery sites on estates in Ceylon, together with the enhanced initial cost of planting material that will result from the discarding of poor seedlings, will possibly give pause to those considering the use of such methods, but the following description of the results of their application in Java will show that advantages accruing may well more than compensate for a higher initial cost of planting. The difficulty of nursery sites is relatively easily overcome, since if areas are to be replanted it will obviously be convenient to use a portion amid the actual tea area as a nursery, uprooting the tea on the site and establishing the nursery a year or more before the main area is cleared.

Too much emphasis cannot be laid on the point that it is essential, if costly replanting is to be done, that every precaution be taken to see that it is done with only the best available material. The mere procuring of several thousand "tea" stumps or so many maunds of "tea" seed cannot be considered sufficient, even if every care is taken to choose a reputed jât. Variation within jâts must be recognised. Once it is, the arrangement of a replanting programme in such a way that nursery sites are available to permit of selection of the good individuals and discarding of the poor becomes a logical, and even an essential, proceeding.

The basis of selection in the nursery must be vigour and uniformity. The selection of plants for vigour is rendered difficult by the fact that the observed vigour of an individual is a function of its inherited constitution, and of the favourableness or otherwise of its particular local environment. Thus edge plants may be better or worse than those in the centre of the bed, and the plants in half the bed may be worse than in the other half. Such differences are mainly due to local variations in nursery environment, and it is therefore desirable to prevent their interference with the selection process. It has been found in Java that this may be best achieved by regarding marginal plants as a separate group and selecting from them and from those in the centre of the beds independently. The paucity of suitable nursery areas in Ceylon renders the alternative of having the seedlings planted in rows at regular distances, and not in beds, rarely feasible. However, such a policy should certainly be adopted where possible when nursery selection is intended.

The problem of differences in growth due to local differences of fertility and depth of soil within the individual nursery bed may be got over by dividing the area into smaller areas and selecting a given percentage of the best plants from within the smaller areas. This procedure is based on the general tendency of fertility variation within

small areas to be less than that within larger areas. The result of experiments has indicated that this method is preferable, both in ease and accuracy, to the method of discarding the worst plants from large areas.

Before describing a method for actual procedure in the field, the criteria to be used for the estimation of vigour and the percentage of plants to be taken remain to be discussed. Selection for height is not desirable as the presence of branches may result in a vigorous plant being shorter than a less vigorous one which has produced no laterals. The weight of branches and leaves obtained when the plant is stumped, or the thickness of the stem at ground level, provides the best measure of vigour, but it is apparent that direct measurement is not suitable as a means of selecting large numbers of plants. An experiment carried out in Java and designed to test the efficiency of selection by eye indicated that the visual examination of the plants in groups of one hundred resulted in from 60 per cent to 90 per cent of the plants selected as the 20 per cent heaviest being found to be in the 20 per cent heaviest as found by actual weighing. The percentage success varied according to the observer. Visual selection thus provides a fairly efficient, while quite practical, method of judging the vigour of the plants.

In passing, it may be noted that the close agreement found to exist between variations in weight of root and in weight of stem and leaves resulted in those bushes selected for most vigorous branch growth being also those with the best root systems.

The research workers in Java have carried out, over a large number of years, experiments designed to determine what yield increases may be expected to result from nursery selection. The degree of effect obtained will naturally increase according to the variability of the original material, and it is apparent therefore that the beneficial results of nursery selection are likely to be larger in the case of the more heterogeneous Ceylon jâts than was found to be the case in the experiments to be quoted, and the process correspondingly more economic. Wellensiek has pointed out that nursery selection is always effective in raising the *average production* from the bushes planted out as compared with the whole population, although of course every individual selected may not prove to be a high-yielder. Very extensive tests of the system are reported by the same author. Seed from seed-bearers selected for evenness of jât (in 1915!) was planted out, and subsequently 19,817 seedlings were examined by cutting them back to 15 cm., and weighing the tops removed individually.

Arranging the weights in classes of 100 gm. the following distribution was found:—

Class size	0	100	200	300	400	500
	10768	6111	7027	595	187	
	500	600	700	800	900	1000
	89	27	8	3	1	
	1000	1100	1200	1300	1400	
	0	0	0	1		

The groups are overwhelmingly one-sided, the vast majority of the plants being relatively very small. (A moment's reflection, bearing in mind that in Ceylon nearly all plants are sooner or later put out in the field, will show that Ceylon's tea bushes consist mainly of bushes grown from those plants which were relatively weakly in the nursery).

The average weight of the 364 (1.83 per cent) heaviest plants was 412.9 gm., of the 3, 913 (20 per cent) heaviest plants 255.1 gm, and of the 'average" plant 116.4 gm. No figure is given for the poorest. The "average" or "standard" plants were planted as controls to indicate the probable average productivity of the whole 19,817 plants, together with the 20 per cent heaviest plants. They were planted at 5 feet × 6 feet to eliminate the effect of competition between bush and bush upon growth.

In April, 1932 the plants were cut across at 60 cm. ($23\frac{1}{2}$ inches) and later plucked at a level of 70 cm. ($27\frac{1}{2}$ inches). Individual yields were determined for each bush over eight plucking rounds; the average yields of the 1.83 per cent heaviest stumps and of the 20 per cent heaviest were found to be 158.5 per cent and 131.4 per cent of that of the "standard" plants respectively.

These yields were computed in half-kilogrammes of dry leaf per hectare to determine what relation they bore to normal yields. Converting the figures given to lbs. per acre, the expected yield from "standard" plants would be 617 lbs. per acre, from the 20 per cent heaviest plants 811 lbs. per acre, and from 1.83 per cent heaviest plants 978 lbs. per acre. The plucking garden reached the age of four years during the course of the experimental pluckings. The twenty-four best yielders cropped at the rate of 2,523 lbs. per acre

In conclusion, the author points out that in an highly efficient tea garden (given even environmental conditions, F.R.T.) every individual yield would differ but slightly from the general average

of the whole plantation. In actual fact, however, the presence of high and low yielders results in low efficiency, with the consequence that, in the case under consideration, selective removal of 10 per cent, 25 per cent, 50 per cent and 75 per cent of the lowest yielders would have resulted in losses of only 2 per cent, 8 per cent, 25 per cent and 50 per cent respectively, in yield.

The same author cites further results bearing upon the relation of seedling vigour to subsequent yield capacity.

Class		Pruning weight of nursery plants in grams	Subsequent average yield, in 8 pluckings in grams
1	...	45.6	157.3
2	...	107.5	164.9
3	...	173.0	170.9
4	...	249.9	171.5
5	...	434.1	192.9
5a*	...	712.0	221.0

(* a sub-division of Class 5.)

Class 5 comprises approximately the 20 per cent heaviest nursery plants and selection to this extent thus gave an increased yield of 12.5 per cent, while selecting to the limits of Class 5a (approximately 2 per cent) increased the subsequent production capacity by 28.9 per cent.

A more complete experiment, in which border plants were considered separately from the centre plants of the nursery beds gave the following results:—

Differences *between* Border and Centre Plants of the Nursery.

Group	No. of Plants	Average Pruning weight in gms.		Average Diameter in mm.	
		In Nursery	2 years after transplanting	In Nursery	2 years after transplanting
Border Plants	613	107.0	608.9	8.6	18.4
Centre Plants	981	52.2	553.4	6.4	18.0
Difference		54.8 ±3.78	55.5±22.17	2.2±0.75	0.4 ±0.35

Differences *within* Border and Centre Plants of the Nursery.

Group	Class	Average Pruning weight in gms.		Average Diameter in mm.	
		In Nursery	2 years after transplanting	In Nursery	2 years after tracsplanting
Border Plants	1	23.3	416.7	4.8	15.5
	2	54.4	557.5	7.2	17.1
	3	84.7	560 8	8.6	18.2
	4	125.2	678.3	10.2	19.9
	5	223.9	735.8	13.1	19.1
General Average		108.0	619.8	9.0	18.1
Group 5a		393.1	1012.5	16.8	23.8
Centre Plants	1	11.6	449.7	3.7	16.2
	2	26.7	487.5	5.4	17.1
	3	41.7	602.5	6.5	18.8
	4	61.7	585.5	7.7	18.6
	5	112.4	683.9	10.0	20.5
General Average		52.8	567.8	6.8	18.3
Group 5a		198.8	735.8	12.1	21.2

It will be seen that the differences between border and centre plants have decreased considerably or have disappeared two years after planting out, while those between different *classes* of border plants and between different *classes* of centre plants decrease but are still observable. This indicates that while the differences between centre and border plants are mainly due to the effect of differences in local environment within the nursery, those between classes within either centre or border plants are partly due to inherited characters which continue to exert an effect after transplanting. As is to be expected, the yields, after planting out, of centre and border plants were found not to differ.

Yields subsequent to planting out.

	1st 48 pluckings	2nd 48 pluckings
Border Plants ...	400.6	807.6
Centre Plants ...	395.7	824.4

The plants described in the following tables were plucked for two pruning cycles, each composed of forty-eight pluckings.

The differences found in the subsequent yields of the plants falling into different size classes as measured by weight, are illustrated by the following figures:—

Subsequent Yields, as Percentages of the General Average of Nursery Plants of Different Sizes.

Group	Class	First Yield Period Pluckings						Second Yield Period Pluckings					
		1—8	1—16	1—24	1—32	1—40	1—48	1—8	1—16	1—24	1—32	1—40	1—48
Border Plants	1	67.2	69.9	71.0	72.2	72.7	73.2	81.4	79.5	77.4	77.2	77.7	77.6
	2	92.8	93.6	94.8	95.5	96.5	96.7	90.4	91.4	92.8	93.4	94.3	95.6
	3	107.4	106.6	107.8	107.9	107.8	107.3	105.8	106.6	108.4	108.3	108.2	107.4
	4	109.5	109.7	109.4	109.7	109.2	108.8	109.0	110.1	109.8	109.8	109.5	109.9
	5	113.8	111.2	108.8	106.9	106.3	106.6	107.8	106.4	105.4	104.9	104.2	103.5
	Group 5a	177.3	171.2	157.5	147.8	146.9	151.8	149.4	143.0	144.3	140.7	140.1	134.0
Centre Plants	1	87.2	87.1	87.3	87.8	88.0	88.1	95.9	93.2	92.2	91.9	91.7	92.3
	2	99.8	99.2	98.1	97.5	97.6	97.4	100.5	99.6	98.8	98.5	98.3	98.2
	3	101.4	100.3	101.7	102.8	103.0	103.7	100.8	100.3	101.1	101.2	101.9	102.5
	4	98.7	97.4	96.9	96.6	96.5	96.1	94.4	95.2	95.3	95.3	95.9	96.2
	5	110.1	112.8	112.6	101.9	111.6	111.3	107.3	110.0	110.7	111.1	110.1	108.8
	Centre 5a	166.2	165.8	157.1	151.1	150.2	149.0	127.4	127.5	131.7	133.2	130.6	130.1

The figures provide an illuminating example of what nursery selection can achieve. For general purposes, the combined figures, including both border and centre plants are interesting:—

Class	First Period	Second Period
1	82.5	87.0
2	97.2	97.2
3	105.1	104.3
4	101.2	101.5
5	109.5	106.6
Group 5a	142.8	129.6

Class 5 consists of approximately the 23 per cent heaviest nursery plants, and the yield is 9.5 per cent and 6.6 per cent above the average yield per plant over the *whole group*. Group 5a, consisting of the 1.3 per cent heaviest nursery plants, gave increases of 42.8 per cent and 29.6 per cent over the *general average*.

In a third experiment quoted in the paper under discussion, the 20 per cent heaviest plants gave an increase of 8.8 per cent during eight pluckings while the 1.8 per cent heaviest gave an increase of 19.3 per cent over the general average. In a fourth experiment the 20 per cent heaviest plants gave an increase of 35.6 per cent and the 1.4 per cent heaviest one of 65.9 per cent over the "central" group of plants, taken as representative of the general mean. A fifth experiment gave a similar increase of 22.2 per cent in the yield of the 20 per cent heaviest nursery plants. The sixth experiment quoted showed an increased yield of 37.1 per cent as the result of selecting the 4 per cent heaviest plants.

The author states that selection of the twenty per cent heaviest plants always led to an increase in yield over unselected material, increases varying from 3.5 per cent (exceptionally low) to 37.2 per cent being noted. In general the stricter the standard of selection the larger the yield increases over the average that occur. The results also confirm the statement previously made that the differences in size between nursery plants are partly the result of inherited differences in vigour, a conclusion that is supported by work in Ceylon. Further, these inherited differences in vigour are later reflected in differences in yield capacity. The author stresses the point that nursery selection cannot result in *all* the good yielders being planted out and *all* the poor yielders discarded, but it does result in the average yield capacity being increased. It is perhaps worth recording that, in the opinion of the Tea Research Institute of Ceylon, similar results would be obtained under Ceylon conditions

and that the magnitude of the increases resulting from selection is likely to be even greater, owing to the greater heterogeneity of planting material in this country.

These figures, and the conclusions derived from them, are sufficient to indicate that nursery selection will enable improved material to be planted in the interregnum that must elapse before better methods and better planting material are elaborated and tested under Ceylon conditions. Before proceeding to outline a practical procedure, the financial implications of the method will be discussed.

Assuming that only 20 per cent of the nursery plants are planted in the field, taking the conservative estimate of a 15 per cent resultant increase in yield, with unselected stumps purchased at Rs. 40 per thousand, the process is not very attractive financially, but it must be remembered that the remaining 80 per cent poor plants can serve an extremely valuable purpose as anti-erosion hedges. It is when the plants are raised upon the estate that selection becomes financially feasible and desirable. If it is possible to grow stumps on the estate at between Rs. 15 and Rs. 20 per thousand, the extra cost involved will lie between Rs. 60 and Rs. 80 per thousand. An increase in yield of 15 per cent will then be likely to return a handsome profit on the extra expenditure.

It must also be borne in mind that it seems likely that the tea industry is passing into a stage of survival of the fittest in which the enhanced yields resulting from improved planting material may have a very material bearing on the result.

Wellensiek has suggested a modification of nursery selection wherein the seedlings are thinned out at six to eight weeks old (probably corresponding to ten or twelve weeks in Ceylon) discarding all but the 20 per cent or 25 per cent best plants, the beds being long and very narrow to reduce border effects. This arrangement avoids discarding so many large plants, but the advantage under Ceylon conditions would appear more fictitious than real, since the whole area would still require watering and attention. Further, chance differences in the amount of seed reserves would play a larger part in affecting the selection process than they would if its application was delayed until later. If abundant seed is available, as is the case when the estate possesses its own seed-bearers, it would be well worth while putting out germinated seed at half the normal spacing, and thinning out fifty out of every hundred ten or twelve weeks later, followed by a selection of the best forty in every remaining hundred when lifting prior to planting out in the field. This would give an effective selection of 20 per cent at about half the extra cost involved by performing the whole selection when lifting,

if the cost of the extra seed is neglected. Such a method is unlikely to be quite so efficient as the first, as differences in spacing, resulting from the first selection, will interfere with the second selection.

It is desirable that the method of actual selection of stumps for planting should be designed to avoid as far as possible the bias resulting from border effects and from fertility gradients within the nursery, while the need for personal supervision of each lifting cooly should be obviated as far as possible. The first desideratum is best satisfied, as already pointed out, by selecting a given percentage from small groups, considering *border* and centre plants separately. Thus, in a bed twenty feet long and three feet wide, containing say seven plants per square foot, a six-inch strip around the outside of the bed would be considered separately. Its area would be twenty-two square feet and from it the $(\frac{9}{1} \times \frac{7}{1} \times \frac{20}{100})$, or say 31 plants which appear the heaviest are selected. The centre of the bed, amounting to 38 square feet would be divided into three equal portions and the $(\frac{38}{3} \times \frac{7}{1} \times \frac{20}{100})$, or say 18, plants of heaviest appearance selected from each. A total of 85 plants will thus be drawn from in the bed, the rest being later used for terracing purposes, at three inches apart in the row. If the alternative plan mentioned above, involving a final selection of 40 per cent be adopted, the figures would have been 62, 36, and 170.

The selection of the heaviest plants should be done by a reliable person who has deliberately practised the art, checking his judgment against actual weighings. If done *in situ*, the plants should be marked in such a way as to be obvious to the lifting cooly, for example by stumping *in situ*. Alternatively the plants in the areas marked out as above may be lifted, and the requisite number of the heaviest plants picked out from the bundles. This latter procedure allows of root character also being taken into account in the selection process.

The desirability of paying strict attention to the type and vigour of the plants put out has always been tacitly acknowledged in Ceylon. In practice, however, the attention paid to the subject has been directed to the purchase of a favourite jât, and the generous treatment of the seedlings to ensure that, when they are put out in the field, they have formed well-developed plants. Neither of these measures take into account differences in vigour and type from seedling to seedling within a bed of a given jat. The time has come, it is suggested, when methods must be altered to allow of the selection of good plants and the elimination of weakly or off type plants from the material used for supplying or replanting.

NEW ASPECTS OF MANURING.*

T. EDEN.

Last October, I took the opportunity of summing up the changes that have taken place in the last ten years in the use of artificial manures. Last time I visited this Association I dealt with the other important branch of manuring — green manuring. On both occasions I gave a picture which surveyed broadly most of the ground that these two subjects may be expected to cover. Today I am so to speak displaying a much smaller canvas and I propose merely to fill in some of the details. Agricultural research is in the nature of things slow work, and though some of the ideas I shall put before you today suggested themselves to me some years ago, I have refrained from giving them publicity until I had some factual proof of their validity to offer you.

I have chosen two quite unrelated aspects of manuring to speak about, both of which are much discussed in planting circles if my correspondence files are any indication of the state of affairs: they are time of manuring in the pruning cycle and the function of manuring in relation to the growth of the whole bush.

PRUNING MIXTURES

In the previous lecture, to which I have referred, I noted in some detail the data and general considerations which led me to question the universal efficacy of pruning mixtures. I shall not repeat that now except to remind you that the response to Nitrogen in the first year of a 3-year cycle was small in comparison with either the preceding two years in the preceding pruning cycle or the succeeding two years in the same cycle. I mentioned that in an actual experiment, at tipping time the new growth was not superior on the plots given an application at time of pruning to those which had received no application. The first year of the new cycle is just complete and the results show the effect of delayed application. Both the three and six-month applications are superior to the one at pruning time itself. The actual figures in pounds per acre speak for themselves. They are as follows:—

Months from pruning ...	0	3	6
Ist year yields lb. per acre ...	629	664	674

* Lecture given before the Madulkelle and Uva Districts Planters' Associations on May 6th and 28th respectively.

Now that some actual data on this point is available the opportunity can be taken to discuss the practical implications. Up to the present my pronouncement has not exceeded the statement that "considerable doubt is thrown on the efficacy of pruning mixtures."

We must first of all consider the conditions under which this experiment was carried out, namely a three-year cycle at an elevation of 4,600 feet with a period of recovery from clean-pruning of 4 months to first tipping and $5\frac{1}{2}$ months to the completion of a third round of tipping.

The conclusion we are entitled to draw then is that a delay in application till tipping time is beneficial: if manuring is delayed till completion of tipping the extra advantage is in all probability not significant. It is necessary to visualize this experiment in terms of growth stages and not in months because otherwise it will be difficult to apply it to differing climatic and cultural conditions. Viewed in this way it is obvious that the advantages of delay in application in the pruning mixture is likely to be less noticeable at low elevations where recovery is more rapid, and particularly with other kinds of pruning such as the so-called rim-lung or cut-across. In both these cases the bush is not left to regenerate itself entirely from stored food reserves, and begins to function normally at an earlier date than with clean-pruning. Summing up on this point, the advantages of delayed pruning mixtures are most marked at high elevations on clean-pruned tea and will lead to some saving in the artificial manure bill. In those districts where drought is a serious problem, and where a considerable amount of dry weather pruning is carried out, delayed pruning mixtures give a period of grace, without any loss of efficiency, to enable dry weather cultivation to be avoided.

PRE-PRUNING MIXTURES

So much for the beginning of a pruning cycle. The end of the cycle is quite as interesting from a manurial point of view. The thesis I have elaborated that nutrients are less economically used at the beginning of a cycle than at other times raises the question of economic manuring towards the end of the cycle. If we employ greater amounts in the last few months than the bush can reasonably deal with, the unexpended portion of that application becomes uneconomic comparatively speaking as soon as pruning has been done. I think that follows logically from what has preceded.

I have not yet experimental facilities for putting this hypothesis to a test of the same stringency as the rest, but I have gathered a certain amount of suggestive data from estates themselves. I have

been interested in these pre-pruning mixtures for some years and have taken the opportunity of examining field data from estates wherever a settled policy of manuring has been in operation for some years. The procedure in dealing with this data is as follows:—

The foundation of the method is the now well-substantiated fact that when manures are economically used, the increment in crop is strictly proportional to the amount added.

Our experiments show that the addition of 1 lb. of nitrogen produces between 4 and 5 pounds of tea. Actually, the absolute value of this coefficient is unimportant for our purpose, but for sake of illustration the value 4 will be taken. We are now in a position to take any given yield over a period, and to assign that yield in part to soil sources of nutrient on the dual assumptions that a known amount of manure has been applied during that time and has been economically used. Thus, if in a ten-month period 662 pounds of tea was harvested, and during that ten months 33.25 pounds of nitrogen was known to have been added, the statement runs as follows:—

Total crop	...	662
Nitrogen equivalent (4×33.25)	...	133
Residual equivalent	...	529

Consider a similar statement made on the basis of only 20 lb. of that 33.25 lb. being used by the plant. Then a truer picture of the balance sheet would be:—

Total crop	...	662
Nitrogen equivalent	...	80
Residual equivalent	...	582

A comparison of these two statements brings out the point I want to stress, namely that *a diminution of the residual equivalent indicates that in the case of the lower value the utilization of added nitrogen has been less efficient*. This loss of efficiency may be due to diverse causes such as drought or other climatic reasons for diminished growth, or to overdosage of manure. but on consideration you will see that lack of response to manure by reason of adverse climate is really only another aspect of the same cause — inefficient use of manures.

In the following examples taken from actual records the pruning cycle is divided into periods between consecutive manurings and the various equivalents calculated. Since the time periods are not

absolutely constant, the residual equivalent is expressed in lb. per month. Climate must play a considerable part in determining the progress of growth over restricted periods, so we shall only consider large differences in values.

Example 1 shows what I consider to be a perfectly normal application of the principle to a short cycle with regular manuring at six monthly intervals. The first six months is anomalous because of the recovery period. The second shows a marked increase in residual equivalent and the third not merely a maintained but an enhanced, value.

EXAMPLE 1

Months from pruning	Nitrogen applied	Yield to-date
0	12	—
6	28.5	106
12	24	450
18	—	826

	1st Period	2nd Period	3rd Period
Yield	106	344	376
Nitrogen equivalent	48	114	96
Residual equivalent	58	230	280
Residual equivalent per month	10	38	47

Bearing in mind that a bush at this time has developed frame and root system it is reasonable to expect that its foraging value and productive plucking points are both increased, and are reflected in the calculated residual equivalent. When with rather closer spacing greatly increased quantities of nitrogen were given the results were those of example 2.

EXAMPLE 2

Period	2	3	4
Months	5-13	14-18	19-23
Nitrogen added	25	41	41
Residual equivalent	58	32	25

The steadily decreasing value of the residual equivalent is evidence that at such close intervals 41 pounds of nitrogen is uneconomically used and is an overdose.

Having demonstrated the principle by an exaggerated example, I shall pass to the consideration of end of cycle applications and show you some figures from a former manurial programme on St. Coombs.

EXAMPLE 3

(a).				
Period	1	2	3	4
Months	6	9	10	7
Nitrogen added	0	34	34	34
Residual equivalent	7	49	60	46
(b).				
Months	4	10	9	6
Nitrogen added	0	33	33	30
Residual equivalent	—	53	81	34
(c).				
Months	5	9	11	5
Nitrogen added	0	34	34	34
Residual equivalent	—	55	62	45
(d).				
Months	4	10	11	6
Nitrogen added	—	33	33	30
Residual equivalent	—	49	78	40

In these examples (a) and (b) are two successive cycles in one field and (c) and (d) similar cycles in another field. All show an increase to a maximum at the end of the 3rd period (20-25 months) and a severe falling-off for the final short period of 5-7 months.

There is no point in piling Pelion on Ossa by giving still more data on the identical point but I have a somewhat striking example in No. 4. Here are two fields which for a period had been on a 3-3½-year cycle with approximately annual manuring which were then put on an extended cycle, and to help them on were given an extra dose during the last twelve months.

The trend of results can in this case be best seen if the residual equivalents are plotted against the appropriate dates. In both cases the special dose following so soon after the 'normal' application has caused the equivalent to fall rapidly. Such a spacing in manuring is thoroughly uneconomic and stands condemned. The tendency in some quarters to apply ever-increasing quantities of manure up to the final dose does not appear to be necessarily a fruitful one, and

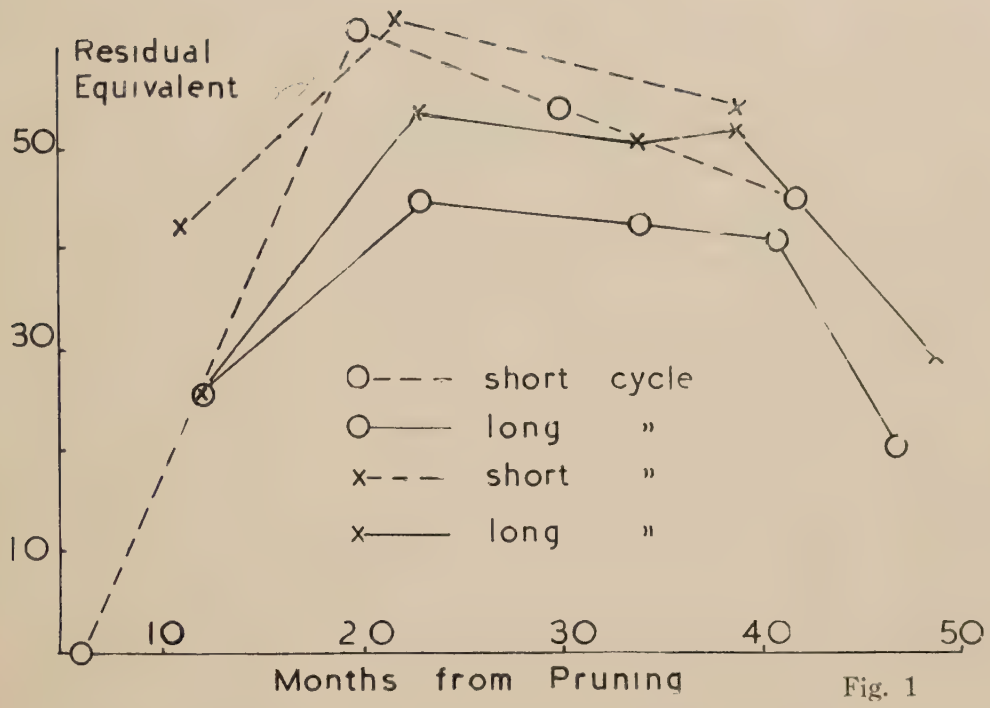


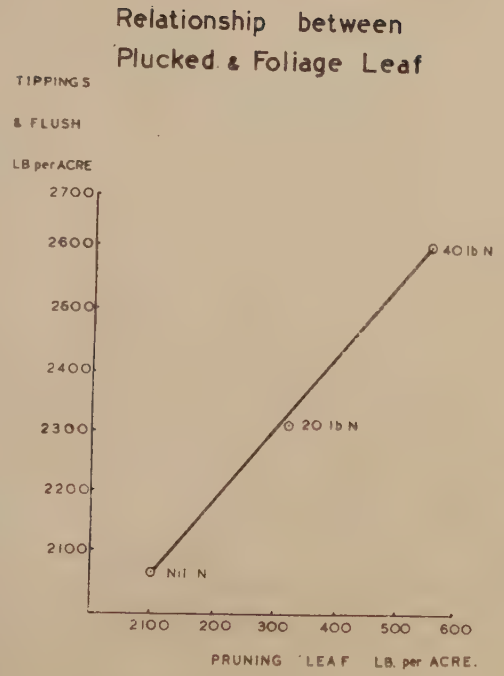
Fig. 1

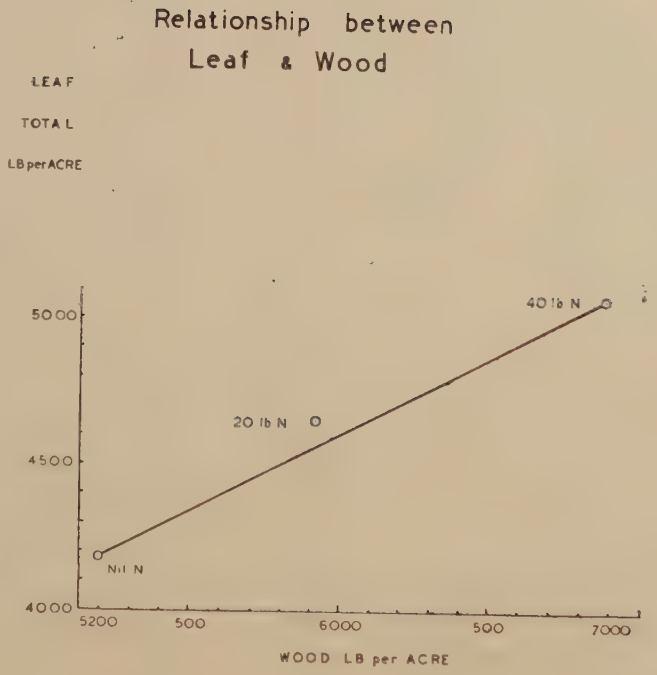
care is particularly needed to see that the final dose is of the size and at a period that allows of reasonable use before pruning. It would be well on principle to avoid periods of less than six months and even then to graduate the dose. We are working on this principle at St. Coombs and shall in due course have further data for examination. In respect of the graduated dosage, it is interesting to note that in going through my collection of figures I find that the maximum residual equivalent appears with real consistency at the end of the 20-25th month. The manuring previous to this date is therefore likely to be the most favourable for crop production.

MANURING FOR CROP AND WOOD

The second aspect of manuring I have chosen can be dealt with very briefly, but as it is important I am anxious to put it on record. Hardly a month goes by without my being asked to prescribe a manurial programme that will encourage wood growth without enhancing crop

Such requests ignore the fact that a plant is an organism and the growth of its various parts is highly correlated. It may be that the behaviour of orchard crops at home is responsible for the prevalence of the idea, but the case of tea is not comparable with that of the apple for example. In the latter case there are two distinct phases of growth, the vegetative and the reproductive. The latter depends upon the food reserves available rather than on direct


Relationship between
Plucked & Foliage Leaf
TIPPINGS
& FLUSH
LB per ACRE
2700
2600
2600
2400
2300
2200
2100
40 lb N
20 lb N
Nil N
2100
200
300
400
500
600
PRUNING LEAF LB. per ACRE.


Relationship between
Leaf & Wood
LEAF
TOTAL
LB per ACRE
5000
4500
4000
40 lb N
20 lb N
Nil N
5200
500
6000
500
7000
WOOD LB per ACRE

nutrition and consequently reproductive growth is alternative to vegetative. But in tea all the growth is of the same type and the direction of growth into alternative channels does not come into play. The conclusion supported by direct evidence is that increased crop and increased wood go hand in hand. The various manurial treatments on our experiments show consistently this close connection. I have drawn out the data for increased quantities of nitrogen as a typical example. First of all there is the relationship between the leaf removed in plucking and that left on to support the bushes' activities. Three levels of nitrogen are considered and the proportionality of the yields as shown by the approximation to a straight line graph is as strict as any experimental demonstration can hope to produce. Similarly the relationship of total leaf and wood, or *a priori* crop and wood is also very close indeed. I hope when this lecture is given the wider publicity of publication it will suppress enquiries of the nature described. There are methods of altering the balance of wood and flush. The obvious one is to stop the plucking stimulus and allow growth to proceed after pruning till a good show of red wood has formed. Manuring will help this during the later stages but it will not be manuring that alters the balance.

NOTE.

In the course of discussion on the above lecture attention was drawn to the high values of the residual equivalent which might make it seem that without manuring a high yield could be obtained. Such a yield might appear to suggest that it would be more profitable to manufacture the yield equal to the residual equivalent rather than to spend money on enhancing crop.

The elucidation of this problem that followed brought out the following points:—

(1) That the hypothetical figures used for comparison refer to crop only.

(2) That the improvement in potential cropping response that follows manuring keeps the bush in good heart and subsequently makes it a better forager. Eventually, therefore, manuring has an effect on the size of the residual equivalent.

(3) That this is so is shown by figures quoted in a previous lecture Vol. X, No. 3, October 1938, where the ratio of crop to added nitrogen is gradually increasing. That this should occur is mainly due to the fact that whilst every application of manure starts where the last left off, the unmanured yields are steadily decreasing, *i.e.*, without manure the "residual equivalent" is not maintained.

(4) Over short intervals of time the residual equivalents offer a sound basis of comparison.

REPLANTING—I.*

F. R. TUBBS

Your Chairman was good enough, while suggesting the subject of "Pruning Cycles," to give me my head as to the subject for today's talk. Longer cycles have been extensively discussed at the last Tea Conference and also in the various publications of the Institute, and while I will be glad to answer any questions on that subject to the best of my ability afterwards, it was felt to be of advantage to discuss today a movement which may well become as wide-spread as that of increasing the length of the cycle has done already. I refer to replanting. A few years ago, replanting was a rarity. Today, in almost every district, there are one or two small areas being done. If the movement grows and spreads, operations involving considerable sums of money will be involved, and it may not be inopportune, therefore, to consider what is involved.

I do not propose to discuss the question of the material with which replanting is to be done, as that of itself raises very large issues which I hope to discuss with the Dimbula Planters' Association at the end of the month. Instead, let us deal with the primary questions of when is replanting desirable, what preparations are necessary beforehand, and on what lines should the actual operations be carried out, of which the first is possibly the most debatable.

The usual reasons given for replanting the relatively small areas that have been done so far are that the area concerned was far below the average productivity of the rest of the estate owing to the condition of the bushes, or was planted with a much poorer jât, or had been placed for a time, under some other crop. What we have to consider is whether these reasons are the only ones justifying replanting. Emphasis was, at the beginning of restriction, placed on the desirability of a thorough supplying programme. This has been fairly widely accepted and acted upon, and some may perhaps ask "Surely continuous and adequate supplying is sufficient. Why talk of replanting." Well, other countries have found it desirable to pull out and replant tea areas containing fewer "passenger" bushes than ours, on the average, include. Further, as a long range policy they

* Lecture given to the Nuwara Eliya District Planters' Association on May 14, 1938.

are probably right, even when one realises that the areas being replanted are fully up to what in up-country Ceylon districts would be called a good hybrid of relatively uniform type. In fact, they are uprooting and replacing what, in some cases, we are still planting. We must also realise that when Ceylon bought large quantities of seed from abroad in the earliest days of the industry it is possible that we may not have been given the cream of the local varieties. Replanting is a subject that should not be ignored in Ceylon and in my opinion there are reasons that may justify the replanting of areas that are not worse than the general average of the estate, where that average is not high.

The spread of the tea industry into new countries, and the position in parts of India where there are not only areas of young tea which have not yet been fully cropped owing to restriction, but also large areas at present being replanted or available for new opening on individual estates, provide the possibility of even lower costs of production being achieved. They are in general already low compared to Ceylon, as far as I was able to judge on a fleeting visit. Now, Ceylon tea has long been in the happy position of commanding a premium in the world's markets. But the apparent value of that premium will become fictitious if the disparity between the cost of production in Ceylon and in other countries, situated more favourably than Ceylon in this respect, is allowed to increase. It is, I think, generally admitted that at the termination of restriction, large acreages of the world's tea will be capable of yielding far more than the present standard assessments. Is this generally the case in Ceylon? And yield per acre is a very cogent factor in cost of production.

I realise that this thesis brings us to a very knotty point — if yields are to be increased to allow of the maintenance or reduction of our present costs of production, what about quality? Frankly, I do not think we know enough yet to be able to answer this question properly, but two observations appear to be justified. Firstly, there are a sufficiency of examples to show that increases in yield achieved by cultural methods are not necessarily associated with decreases in valuation. Secondly, I see no reason why this should not be equally true in the case of increases achieved by replanting. The task before us, in my personal view, is to maintain our market premium while preparing to face even greater competition resulting from disparity in costs of production.

The consideration of costs of production, with the sequence of thought to higher yields and thence to replanting, is not the only direction in which the importance of a correct decision upon the subject becomes important. It is also necessary to consider the

future of the existing bushes. Take for example, an estate of five hundred acres, on which the tea is thirty years old, whose Directors are willing to adopt a permanent policy, which today would be revolutionary in Ceylon, namely that of steadily replanting five acres every year. Some of that tea will be 130 years old before it is replanted!

It may be justly objected that this is not quite a complete picture and that the supplying of vacancies will result in the replacement of a large proportion of the bushes before then. Granting this, if we rely indefinitely on supplying, we are faced with the consequence that existing conditions will be perpetuated, whether we like them or not. Lines must still run up and down hill, bush heterogeneity is to be further accentuated by supplying with whatever jât happens to be available when required, and no radical improvements are possible. It may be replied that firstly no one here is likely to be interested in 2038 A.D., and secondly that it is better to wait for the production of improved types of tea before considering replanting. The first is, I think, met by the fact that we are all here in greater or less degree as trustees, but the second has more force. I hope, since it is now my job, that improvements will be made in the types of tea plant available for planting purposes, but I am under no illusion about the lengthy nature of the task I am engaged in. However, the point must not be lost sight of that, in an unselected crop like tea, even the roughest methods of selection can give marked results. It should not be difficult to achieve not only replanting, but also replanting with improved material, even if that material is not as good as what may later be obtainable. We cannot postpone the consideration of replanting until the Cox's Orange Pippin among tea plants has been located and distributed to the industry. Can we afford to delay for ten or twenty years or more a process which, if replanting of five per cent of the acreage per annum is envisaged will take still a further twenty years to achieve?

The cost of replanting properly must give us pause. Replanting is really the payment in a short time of depreciation that has fallen due over many years. Something of a stir was made in the local papers over the statement that the rubber tree was a depreciating asset — but is not the same as true of tea as of all living organisms? The expectation of life of a mature organism must always be decreasing and its capital value therefore depreciating.

If depreciation has to be met, the best way is to make it as easily paid as possible. Now, under normal circumstances, the cost of replanting would be the expenditure plus the loss of profit until yields equalled that of the old tea, after which returns would be

expected to accrue in the form of an increase of crop above what the old tea would have yielded. But, provided coupon purchases have not been so great as to result in the estate being cropped to capacity during restriction, the loss of crop from the replanting of small acreages can be made up on the rest of the bearing acreage. In other words, restriction allows of replanting being, done more cheaply now than will be possible after its termination. This point it seems to me has a particular application in Nuwara Eliya, where supplies and young plants grow so slowly.

These general observations on replanting are my own opinions, and it is not suggested that they are complete or necessarily entirely correct. I do, however, think that the considerations I have mentioned are too important to be ignored, whatever the decision arrived at in the case of individual estates.

Turning now to the second of the three questions I mentioned earlier, assuming replanting is decided upon, what preparations are advisable beforehand?

Firstly, the programme should be mapped out well in advance. There is no point in paying special attention to pruning, mossing and ferning, root growth, etc., on an area that will be replanted in the next five years. If the land is to be redrained, existing drains may be partially blocked and allowed to silt up previous to replanting. Thus substantial savings may be made and offset against the cost of the programme. At the same time as preparations such as these are made, active steps to put leader drains into good order should be taken, since they are likely to remain untouched even if new lateral drains are dug.

There is thus much that can be done before the actual replanting is started. But one of the most important steps of all has been left out — I refer to the preparation, well in advance, of nursery sites sufficient to provide plants for at least two-and-a-half times the area to be replanted, and preferably more, if selection is to be carried out. Nursery sites are admittedly a problem but in this connection there are two points to be stressed — firstly, that if a field is to be replanted, nursery sites can be prepared in it beforehand by cutting out the tea on the area required beforehand, and secondly, that water can usually be got by piping. One of the most pungent comments I have heard by visitors to the Island, if tea types are not considered, referred to our habit of taking nurseries to water, irrespective of soil, rather than water to nurseries.

Some may feel that seed-at-stake or basket plants will save the necessity of worrying about nurseries for stumps. Before they decide upon this, however, I suggest that they make themselves

familiar with the results obtainable by nursery selection, an account of which is appearing in the next number of *The Tea Quarterly*. I am optimistic that the next few years will see a greater evenness in the type and vigour of seedlings produced from seed gardens whose managements determine to work for it. But so long as tea is propagated from seed, the desirability of nursery selection will remain. Even if we end up with clonal seed gardens, there will still be some variation in the progeny, though very much less than at present, to justify the policy of taking the good and discarding the bad.

Turning now to problems associated with the actual process of replanting, the three main considerations appear to me to be, leaving planting material out of the account, reduction of erosion, close planting and a speedy attainment of yielding capacity.

The first requires special attention during the uprooting of the old tea, and it is very desirable that drains in the area which are not already converted to lock-and-spill or reverse slope types should be attended to beforehand. Grass clods or thick rows of bush green manure on the edges of drains will hold up a great deal of soil that would otherwise be lost during the process.

After uprooting, care should be taken to ensure that the soil is not left fallow. If uprooting is done thoroughly, "cultivation" is very deep and thorough, and a plain forking soon after to remove root fragments and permit of the burying of all small twiggy matter and leaves will be all that is required.

Lining should follow as soon as possible, and this brings us to the problem of contour planting. It is not going to pay to hold up the work and leave the soil exposed to rain and sun while we try to produce an array of pegs that would evoke the admiration of the Survey Department. If the contour is followed with reasonable accuracy, but with sufficient latitude to allow of spacing to eliminate short rows, all the major effects of contour planting on erosion will be obtained and with far less time and trouble. The Institute has recently adopted a spacing of 4×2 feet, giving 5,300 odd plants per acre; this is a compromise, as such a decision must be, between the aims of high, but still reasonable, bush numbers per acre, the need for close planting in the row if soil is really to be held up by the bushes, and a sufficiency of space between the rows to allow of cultivation and the growth of green manure. I do not say this spacing is ideal but it seems to me to form a fair compromise. We have also areas of $5 \times 1\frac{1}{2}$ and $4 \times 1\frac{2}{3}$ planting which will later form interesting comparisons.

Immediately pegs are in, the holes should be cut; and here I would point out that there is no point in leaving the holes open — once you have seen that they have been properly cut, they should be filled.

In passing, it may be noted that recent experiments have suggested that soaking stumps overnight in a dilute solution of a nitrogen compound before planting may exercise a distinct beneficial effect on the percentage of plants establishing themselves under difficult conditions.

When the plants are established, plucking them as early as possible is suggested — but very lightly and very carefully. Early light plucking, provided it is done with care, does no harm and may help to offset the cost of replanting.

It may be of interest to close with a short account of methods of replanting that I saw in a part of North-East India. When I tell you that the advisability or the reverse of tractor ploughing of the uprooted area prior to replanting was a subject of discussion, you will have some idea of what we are competing with!

Planting is carried out with magnificent nursery plants, lifted with balls of earth attached to the root, and transferred with great care to the field. The result is that they have the equivalent of a two-year-old clearing in as many months. The nurseries are always made closely adjacent to the area to be planted, and frequently only a small proportion of the seed — that germinating most quickly — is used. The seed, incidentally, is about twice the size of ours, and the young plants are remarkable for their size and uniformity. Growth is aided by copious applications of liquid manure — made by mixing about six inches of dung in a barrel with water sufficient to fill it and allowing the whole to stand, with an occasional stir, for three or four days. I would strongly recommend this being done more frequently in Ceylon, but would stress the point that a thorough soaking of one bed will do more good than a driblet applied over the whole nursery. Perhaps because of the difference in seed size, nitrogen has been found to have little or no effect in the first year of growth, whereas in Ceylon I think the seedlings respond as young as six or eight months.

The eighteen-month or two-year-old plants, sometimes four and five feet high, are planted out untouched, so that what was a clear space yesterday becomes a field of tea today. Grass is applied around the plant to shade the soil and a few days later any plants which have flagged are replaced.

It was of interest that on one, at least, of the estates seen, the spacing was being reduced. In the area I was in, I was informed that from 20 to 40 per cent of the tea was being, or had been, replanted with higher and more uniform jât.

In the Wynaad District of South India, the case is different, for all their tea is relatively young and certainly very even, and I gained the impression that in many cases the estates have not yet been fully cropped. Nurseries were again magnificent and the evenness of the jâts was second only to what I had seen in North India.

My impressions are those gained from restricted areas on an all too short visit, and I would not therefore claim them to be complete; I certainly recommend those of you who can, to go and see for yourselves — but I warn you in advance that the kindness and hospitality you receive will be overwhelming.

DISCUSSION

The Chairman thanked Dr. Tubbs and invited discussion.

Mr. Thornton asked whether there was any evidence that young tea necessarily yielded more than 30 to 40-year-old tea.

Dr. Tubbs replied that it was quite impossible to give a general answer to such a question. He would not deny that possibly even very old tea could give high yields if the soil was good, it was well-manured, and the bushes were not suffering from the effects of past treatment. In other words, the answer to the question was entirely dependent on the local conditions and it was quite impossible to state that at a certain age the tea bush would cease to be as profitable as a younger one. If such a statement was feasible, it would have been possible in the past to depreciate the tea at a fixed rate in preparation for replanting the tea on a given date. There was no doubt that tea growing on deep fertile soil would remain profitable much longer than tea on less fertile soil, where the effects of wood rot in the frames tended to be much greater. Even when the frames were distinctly poor it was possible to renovate the tea by collar pruning and thereby carry on for some considerable time longer, but he felt that such a suggestion did not eliminate the possibility of the necessity for replanting occurring later. No one would willingly contemplate replanting large areas in a very short time, and what he was asking them to consider was whether the time had not come for the process to be started, so that it could be done in relatively small areas at a time. What had first to be decided was whether we were willing to face the question of future replanting. The date at which the process is started and the acreages dealt with annually must be decided subject to the conditions obtaining on individual estates and individual fields.

Mr. Thornton further asked whether the lecturer knew of any tea actually dying out from old age.

Dr. Tubbs replied that it was unlikely that a tea bush would die purely of old age, but as the bush became older the prejudicial effects of the accidents of environment and of treatment in the past reached a greater cumulative total and the capacity of the bush to withstand a new set of prejudicial circumstances became less. Very little indeed was known of *purely* age effect on trees but it was known that different species varied considerably in the average age attained; compare, for instance, the Chestnut and the Churchyard Yew. It was possible that individual tea bushes would also vary in this respect.*

Mr. Howard asked whether collar pruning might not prove a much cheaper alternative to replanting.

Dr. Tubbs replied that he had not sufficient knowledge of collar pruning in that district to say for how long yield would be lost, but if it was for some considerable period, could the process be called economic when viewed from a far-seeing point of view ? He had attempted to raise the question whether, if replanting had at some time to be undertaken, it was not desirable to start the process now. Renovation by collar pruning gave little opportunity of increasing the bush numbers, or of increasing the effectiveness of anti-erosion methods.

In a reply to a question by **Mr. Tunnard,** as to whether it was worth replanting areas where there were only a few inches of soil left,

Dr. Tubbs said that where beneath very shallow soil slab rock occurred, he would not consider it a suitable area for investing the sums necessary to carry out proper replanting, but where there was a good sub-soil thorough cultivation, using the term in the widest sense, would permit of what was practically the making of a new soil layer. He considered that the question of the depth of penetration of the taproot had been given undue importance in Ceylon where, in general, it in any case rarely penetrated deeply. Where the old planting methods had resulted in the course of time in loss of all the upper soil, it was very necessary that any method of replanting considered should allow for efficient contour planting to prevent the remade soil being lost once again.

Mr. Tunnard asked whether Dr. Tubbs would advocate removal of China tea which was forming a good cover over the soil, and raised the question of interplanting with other jâts.

Dr. Tubbs replied that the possibility of interplanting old tea was already a subject of experiment at St. Coombs, but that he would not advocate mixing jâts. He wished it to be clearly understood when speaking of jâts that he was not in a position to say that any one jât of tea was superior to any other jât, and that in a case like this he would require to know more details of the local conditions and history of the fields before he would advocate replanting China just because it was China.

* It may be added that if replanting of 5 per cent of the acreage each year is encouraged, it is desirable to start the programme 20 years before casualties, from whatever cause, become very numerous.

Mr. Tunnard gave further details of his experiences, stating that high jât tea replacing China had taken a considerable time to come on.

Dr. Tubbs said that he would wish to see the particular area before expressing an opinion. If, after considering the question of whether progressive replanting would become desirable in the relatively near future, it was decided to embark upon such a policy, it was necessary to make up one's mind to leave out of the programme those areas which a reasonable man might consider to be incapable of making a fair return. It was very important that improved planting material and methods should not be wasted on areas which could never repay the attention spent on them. He was, therefore, by no means an advocate of a policy of replanting only the worst areas since it might lead in the long run to loss rather than profit.

REPORT ON VISITS TO SMALL-HOLDINGS IN THE KANDY AND BADDEGAMA DISTRICTS.

T. EDEN

During March and April visits were paid to both the districts in which small-holdings work is being carried out. There are points of similarity between the two areas, but the differences are equally marked and in some respects, to be dealt with later, a difference in treatment and recommendation is called for.

Since the small-holder is not usually in a position to lay out money on which he cannot expect a return for some considerable time, the scope of our recommendations has had to fall within quite well-defined lines. Usually it has meant that we could suggest improvements that involved personal labour and attention, but that expenditure of money was ruled out. In so far as rational treatment of tea brings an increased crop, our advice has quite obviously improved the position of holdings, but the main work has been to prevent utter neglect and to concentrate on the conservation of the soil.

The state into which land that is never cultivated, has no drains, no cover, no shade, and which is steadily invaded by illuk, can fall as easy to imagine. It is from a situation such as this that

progress is to be measured. Drains have been dug, or reclaimed, generally on the reverse slope principle. Gliricidia has been planted, weeding has received periodic attention, albeit generally it is mamoty weeding, and protection of soil slopes by terraces and paspalum bunds above drains is becoming more common. More use could be made of green manure shade trees, especially by planting live hedges on the boundaries. Apart from their contribution to green manure supplies they would settle the frequent dispute as to the boundaries themselves. Few of the holders were cattle owners, but where this was the case the manure was used either direct or for composting and regular cultivation given.

On the holdings which have been for the longest period under our inspection, there is justifiable pride on the part of the owner in the result. In many cases the holder thought that the Rs. 10 fee for claiming reassessment would be well spent and he was intending to act accordingly.

It was along the line of permanent improvement that most progress had been made. The day-to-day management of the crop left more to be desired. Dr. Gadd last year drew attention to the absence of drainage outlets from many small-holdings, and the difficulties are so great that they are worth putting on record again. The Soil Conservation Officer from the Department of Agriculture, Mr. W. C. Lester-Smith, kindly accompanied me on my tour of the Kandy District and the problem was given thorough consideration. In many cases, holdings flank the fan-shaped tracts of hill paddy that occupy ravines. From the point of view of normal topography these ravines constitute the natural drainage outlet from the surrounding land. In many instances, however, the boundary between the paddy field and the small-holding is an *ela* which feeds the paddy terraces with water. In the absence of a central *ela* this channel forms the only feeder for the paddy land. Any run-off from higher land falling into these boundary *elas* eventually silts up the paddy fields, and claims for damages are sustainable in the Courts.

The improvement in drains will lead to the risk of damage being reduced, but the laws of nature cannot be altered by legislative ordinance, and water will continue to fall from higher to lower levels. However desirable it is to protect paddy land, the blame for this situation rests partly on the paddy cultivators themselves, since they have commandeered the natural drainage channels as inflow channels. The Soil Erosion Committee of 1931 dealt at some length with external drainage: it admitted the claims of the paddy owners, but seems to have missed entirely the crux of the problem. A similar state of affairs exists as regards roads.

The Kandy and the Baddegama districts differ in the possibilities of erosion control. The former includes a proportion of very steep land and stone is not plentiful. On this land reverse slope drains offer the best solution where existing drains are present, but in the case of newly-cut drains the bunded drain proves more effective. In Baddegama, however, the slopes are more gentle and the ground is frequently rocky. On this land reverse slope drains are frequently likely to be so irregular as to lose much of their virtue. Even bunded drains are at times difficult. Much, however, can be done with rough stone terracing. The small-holder himself realises this, and in many holdings terraces date back from a time prior to the work of the Institute. Sometimes repair work has been neglected, sometimes the building up of the wall has not kept pace with the levelling up of the terraces.

Supplying has been treated seriously in both districts. Seed-at-stake is invariably used. Jâts are many and varied. In the Kandy district they are on the whole poor, but near to an estate which has good seed gardens nearly all the tea was of very good jât. In fact many of the holdings were of as good jât and as well supplied as company estates. In the Southern Province the jât was more uniform.

In treating the bush during its pruning cycle much depends on current prices for leaf. At the time of my visit to the Kandy District the prevailing price was only $\frac{3}{4}$ to 1 cent per pound. The plucking was consequently indescribable and approximated to tipping. A few, more favoured financially than the rest, were letting their tea run up and were producing good wood. They were instructed on the question of subsequent treatment of the bush. Most, however, were plucking when the bought leaf market was favourable, and resting when not. The ragged appearance of the bushes was consequently not surprising. At bottom this is not an agricultural question, and there seems little hope of advance until bought leaf factories demand good quality leaf and pay for it accordingly. In Baddegama the leaf was higher in price and plucking was in progress nearly everywhere. Some semblance of a plucking table was to be found on most holdings.

It follows from the preceding description that when tea has been thus treated good pruning is made difficult. In very few of the holdings visited was pruning done by the holder himself. Generally it was carried out by village bands, or by Sunday labour from neighbouring estates employing Tamil labour. Following on

after good general cultivation practices, good pruning with attention to lateral spread seems to be the avenue along which development could best be helped.

On several occasions there was undisputable evidence that the work of the Institute was bearing fruit not only on the holding that had been supervised for some time but on adjoining holdings where at the moment the contact is not direct, where, that is, example has been better than precept. There is a limit beyond which the number of holdings visited cannot extend without the work losing effectiveness. In some areas holders can be left to fend for themselves with an occasional visit for encouragement. The work that the Institute has done will bear its best fruit when the owner of a neglected holding copies his more active neighbour and the convert himself becomes a missionary. John Bennett Lawes, the owner of Rothamsted, pursued his investigations on his home farm, and as a result of "farming over the fence" the yield of wheat in Hertfordshire increased by about ten bushels in a decade. In a humbler way the Institute's tutelage should be conducive to the spread of sound agriculture amongst the small-holders.

NOTE ON SOIL CONSERVATION.

With reference to the article entitled "Waste Material from Ravines" published in *The Tea Quarterly*, Vol. X, 1937, page 155, we are indebted to Mr. W. C. Lester-Smith, Soil Conservation Officer, Peradeniya, for the following note:—

"In the first place may I refer to *Bryophyllum pinnatum* of which you state 'it has yet to be discovered whether it will thrive under drier conditions.' In this connection you will probably be interested to know that this plant is now by no means uncommon, growing in waste places such as in roadside hedges, low scrub jungle, and even dry rocky and sandy banks in the Hambantota District of the Southern Province. I saw it on my last circuit in that area within a few miles of Hambantota town, where the average rainfall is about 42 inches per annum and prolonged spells of very dry hot weather are not at all infrequent. L. H. Bailey on page 584, Vol. I, (2nd Edition, 1933) of his 'Standard Cyclopedia of Horticulture' states

as follows regarding Bryophyllums generally: 'they are very tenacious of life and will survive with a minimum of water and a low, but not freezing, temperature.' *Bryophyllum pinnatum* is one of the Tropical African succulents, a grouping which includes many xerophytic plants that are adapted to survive almost desert conditions for considerable periods.

"In view of the above I therefore consider that *Bryophyllum pinnatum* is capable of thriving well under any dry conditions it is likely to experience in Ceylon, and, since it is not a difficult plant to eradicate, I agree that there is no danger of it becoming a serious weed.

"It is perhaps of interest also to note that the thick fleshy leaves of this plant are often found with large, irregular shaped, blackish spots on them. In most cases these spots represent leaves attacked by the caterpillars of one of our small Lycaenid butterflies (*Talicada nyseus*) (Ormiston, Butterflies of Ceylon, 1924, p. 47). The caterpillars of this butterfly eat into the leaves, live inside them, and feed on the succulent inner leaf tissue till they are fully fed. They are said to pupate outside the attacked leaf which may or may not be shed by the plant according to the extent of the damage done to it by this insect.

"Secondly, may I refer to the statement, with which I am in full agreement, that 'there is a definite need of plants which can be left in the ground for a considerable time,' for utilization as contour hedges for holding up the soil on steep slopes.

"I am very hopeful that another xerophytic plant, which is not uncommon in the Kandy District, namely *Sansevieria guineensis*, the Sword-plant, though not of any use as a source of green materal, may prove extremely suitable for the purpose in view. In fact so hopeful am I of the utility of this plant for contour hedges in both tea and rubber, but particularly in closely planted crops, that I am definitely recommending it for trial on several areas. It has special advantages in tea over most other plants I can think of, in that it will grow in almost any soil, however rocky or dry, it takes up very little space, does not spread rapidly and cannot be plucked with greenleaf in plucking even if growing up through a bush. It belongs to the Lily family and has a close relative (*S. zeylanica*) which is indigenous, but this species, in my opinion, is not so satisfactory since it does not grow so tall and forms a less effective barrier because the aloe-like leaves tend to grow out more at an angle instead of growing up straight; they are narrower and have their margins curved inwards instead of being broad and more or less flat. I consider that the Sword-plant has great possibilities for use

on the steepest and rockiest of slopes and particularly for those tea estates on which, may it be lamented, clean weeding is still practised. I do not know, however, up to what elevation this plant will grow in Ceylon."

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 23-12-37.

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, on Thursday, 23rd December, 1937, at 2-30 p.m.

Present.—Mr. James Forbes (Jnr.) (Chairman), the Acting Director of Agriculture (Mr. E. Rodrigo), the Hon'ble the Financial Secretary (Mr. H. J. Huxham), the Chairman, Planters' Association of Ceylon (Mr. R. P. Gaddum), the Chairman, Ceylon Estates Proprietary Association (Mr. D. T. Richards), Mr. J. D. Hoare, Major J. W. Oldfield, M.C., C.M.G., O.B.E., Mr. I. L. Cameron, Mr. J. C. Kelly, Col. T. G. W. Jayewardene, V.D., and Dr. R. V. Norris (Director, T. R. I. and Secretary).

Letters expressing inability to attend were received from Mr. R. G. Coombe and Mr. T. B. Panabokke.

1. The Notice calling the Meeting was read.

2. The Minutes of the Meeting of the Board held on the 25th October, 1937, were confirmed.

3. MEMBERSHIP OF THE BOARD AND SUB-COMMITTEES

The Chairman welcomed back from leave Messrs. Richards, Oldfield and Cameron and congratulated Mr. Richards on his election to the Chair of the Ceylon Estates Proprietary Association.

Mr. Forbes also welcomed Mr. Kelly on his re-election to the Board and referred to the valuable services Mr. Kelly had previously rendered to the Institute.

A cordial vote of thanks to Major C. E. Hawes and Messrs. Attfield, Bond and Sharrocks for their services on the Board was recorded.

(a). Reported that Mr. I. L. Cameron on his return from leave had resumed his place on the Board, relieving Mr. W. H. Attfield as from 2nd December.

(b). Reported that Major C. E. Hawes vacated his seat on the Board as from 24th November on resigning the Chairmanship of the Ceylon Estates Proprietary Association.

(c). Reported that Mr. D. T. Richards became an *ex-officio* member of the Board as from 24th November on assuming the Chairmanship of the Ceylon Estates Proprietary Association.

(d). Reported that Mr. F. A. Bond resigned from the Board as from 6th December and Mr. J. C. Kelly had been nominated by the Ceylon Estates Proprietary Association to fill the vacancy as from the same date.

(e). Reported that Major J. W. Oldfield on his return from leave has resumed his place on the Board, relieving Mr. R. A. Sharrocks as from 26th November. Major Oldfield had been re-nominated by the Ceylon Estates Proprietary Association for a further period of three years as from 1st January, 1938.

(f). Reported that Messrs. James Forbes (Jnr.) and J. D. Hoare had been renominated by the Planters' Association of Ceylon as Members of the Board for a further period of three years as from 1st January, 1938.

(g). Mr. Forbes proposed from the Chair that Mr. J. C. Kelly be nominated to serve on the Finance Sub-Committee. This was approved.

4. FINANCE

(a). The Institute's accounts to the 30th November, 1937, were approved without comment on the motion of Mr. R. P. Gaddum, seconded by Col. T. G. W. Jayewardene.

(b). *Tea Research Institute Estimates for 1938.*—The Chairman explained that the estimates had been circulated to members and comments received had been considered by the Finance Sub-Committee. The Estate Estimates had also been scrutinised and approved by the Experimental and Estate Sub-Committee.

Research Revenue Expenditure.—Read letter from Mr. Cameron suggesting that vote 31A (Miscellaneous Field Experiments) be increased to permit of more extensive field investigations on termites.

The Director gave details of the work recently carried out by the Entomologist which indicated that the damage caused by termites was probably less serious than generally supposed. The Director said a report by Mr. King would be published in the next *Tea Quarterly*. The vote was approved without change.

Read letter from Mr. R. G. Coombe suggesting that Vote 62, Upkeep of Grounds, be increased, and reported that the Finance Sub-Committee had recommended an addition of Rs. 200. The vote was passed at Rs. 800.

Vote 24A Joint Work on the Chemistry of Tea Rs. 5,000.—The Director said the Engledow Committee had strongly supported his proposal that work on the chemistry of tea should be carried out in England, being financed jointly by the producing countries. The matter has been under the consideration of the Indian Tea Association and he expected shortly to receive their suggestions. It was likely that the proposal would be for an annual grant to one of the University Laboratories.

The Chairman said that the Finance Committee were in favour of the vote being approved. Detailed proposals would later be submitted to the Board for their approval or otherwise.

The vote of Rs. 5,000 was approved.

The Director said the full vote would not be required in 1938 and asked permission to utilise a portion of the unexpended sum for obtaining translations of certain Russian technical journals in which valuable papers on the Chemistry of Tea had been published.

Major Oldfield asked whether the Cambridge University Press were not making such translations. In reply, the Director said he thought Major Oldfield was probably referring to the translations and abstracts prepared by the various Imperial Agricultural Bureaux. These, however, did not cover the subjects in question.

The Director was authorised to incur the suggested expenditure.

"Contingencies."—The Financial Secretary suggested that the title "Contingencies" should be changed to "Miscellaneous" as the votes under this major head were all for recurring items of expenditure. This was approved.

On the motion of Mr. Cameron, seconded by Mr. Hoare, the Board unanimously approved the amended estimate, amounting to Rs. 233,375, for Research Revenue Expenditure.

Research Capital Expenditure.—The Chairman said that the Finance Committee had considered a proposal by Mr. Coombe that provision should be made for a small resthouse and were in favour of this proposal.

The Chairman referred to the accommodation available in Talawakelle and said he thought there would be general agreement that accommodation should be available on St. Coombs. He appreciated the hospitality shown by the Senior Staff but considered it unfair to depend on this indefinitely.

Mr. Cameron referred to the probability of accomodation being required in the future for instructional courses and supported the proposal.

The Director said that he had been asked in London if provision was likely to be made in the near future for a resthouse. He enquired what amount of accommodation it was proposed to provide.

Major Oldfield suggested that three bed rooms would probably suffice as a start, the building being designed in such a way as to permit of future extension.

After further discussion the Chairman and Director were asked to obtain plans and estimates and to submit these to the Board with details as to the probable running costs of a resthouse.

The Estimate for other Research Capital Expenditure amounting to Rs. 4,985 were approved on the motion of Mr. Gaddum, seconded by Major Oldfield.

Estate Estimates.—The Chairman said no comments had been received on the Estate Estimates as passed by the Experimental and Estate Sub-Committee and the Finance Sub-Committee were in favour of their acceptance.

Mr. Richards proposed and Mr. Gaddum seconded that the allocation of General Charges as to 83⅓ per cent on Working Account and 16⅔ per cent to Capital be approved. This was carried after the Chairman had explained the basis of this division.

On the motion of Col. Javewardene, seconded by Mr. Cameron, the Board unanimously approved of the Estate Estimates, viz:—

Working Account Rs. 96,276 or 52.03 cents per pound.

Capital Account Rs. 22,091 or 11.95 cents per pound.

(c). *Tea Research Institute Cess.*—The Chairman reported that the Finance Committee, with the co-operation of the Financial Secretary, had further considered this question and their recommendations

had been circulated to the Board. The proposal was that the cess should be renewed at 14 cents for a further period of five years.

On the motion of Mr. Gaddum, seconded by Mr. Cameron, the Board unanimously agreed to ask that the cess be maintained at 14 cents until 31st December, 1943.

5. SENIOR SCIENTIFIC STAFF

(a). Reported that the Seal of the Board was affixed on the 2nd December to the new agreements with the Director, Mycologist, Agricultural Chemist, Entomologist and Superintendent in the presence of two members of the Board and the Director.

(b). The Board approved in principle of the Entomologist attending an International Entomological Conference to be held in Berlin in August, 1938. The Director was asked to supply further details of the expenditure likely to be incurred.

6. JUNIOR SCIENTIFIC STAFF

(a). Reported that Mr. Koch, Assistant to the Plant Physiologist, returned from sick leave and resumed duties on the 1st December, 1937.

(b). *Leave Conditions for Junior and Subordinate Staff.*—A memorandum by the Director (Circular No. 41/37 dated 17th December, 1937) giving details of the present leave regulations in the Institute and in Government Service and making proposals for revised leave rules, had been circulated to the Board.

The Chairman invited comments on these proposals.

(a). *Junior Scientific and Clerical Staffs.*—After discussion the Board, on the motion of Col. Jayewardene, seconded by the Financial Secretary, unanimously decided to accept an amendment by Col. Jayewardene that accumulation of leave be permitted up to 50 per cent of the period due in any one year, and approved of the draft rules thus amended.

The Financial Secretary suggested that in all cases of illness extending over two months, the officer should be required to appear before a medical board, and the prospects of ultimate recovery in a reasonable period of time should be taken into consideration when granting further leave.

The Director said provision for this safeguard would be incorporated in the rules drawn up to implement the Board's decision.

(b). *Other Staff.*—The Board approved of the Director's proposals with the proviso that a similar arrangement in regard to Medical Boards should be included in the rules.

7. ANY OTHER BUSINESS

(a). *Visit by Sir Frank Stockdale.*—Recorded that Sir Frank Stockdale will be paying a short visit to Ceylon in April, 1938, and an invitation had been extended to him to pay an unofficial visit to St. Coombs.

(b). The Board recorded a vote of thanks to the Ceylon Chamber of Commerce for the facilities granted for holding meetings in their Committee Room.

(c). Mr. Gaddum on behalf of the Board extended the compliments of the season to the Chairman and Scientific Staff, and the Chairman acknowledged Mr. Gaddum's remarks.

This completed the business of the meeting.

ROLAND V. NORRIS,
Secretary.

NOTICES.

The Institute's Laboratories and Offices are situated at St. Coombs, Talawakelle, and all applications and enquiries should be addressed to the Director, Tea Research Institute, St. Coombs, Talawakelle.

Specimens and other consignments sent by rail should be forwarded to Talawakelle Station c/o Messrs. Hemachandra & Co., Forwarding Agents.

Visitors' Day.—The *last* Wednesday in each month has been set aside as Visitors' Day at St. Coombs Estate and also at the T. R. I. Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the Stations.

Visitors at other times are welcomed, but it is requested that an appointment be made if possible.

ROLAND V. NORRIS,
Director.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. G. Coombe

(2) Mr. Jas. Forbes (Jnr.), (Chairman)

(3) Mr. J. D. Hoare

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Major J. W. Oldfield, M.C., C.M.G., O.B.E.

(5) Mr. I. L. Cameron (on leave) Mr. C. E. Hawes (acting).

(6) Mr. J. C. Kelly (on leave) Mr. K. W. Taylor (acting).

(C) Representing the Low-Country Products' Association :—

(7) Colonel T. G. W. Jayewardene, V.D.

(D) Representing the Small-Holders :—

(8) Mr. T. B. Panabokke

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture

(11) The Chairman, Planters' Association of Ceylon

(12) The Chairman, Ceylon Estates Proprietary Association

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

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The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with the *Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.